

## THE GREEN RIVER BASIN

The Green River Basin is located in West Central Kentucky and Northern Tennessee. The first section of this report will deal with the general description of the area. The second section will enter into an analysis of the water quality in the basin, its causes and effects. The third section of the report summarizes the water quality of the basin and the correction needs.

### I. A Description of the Green River Basin

#### A. Geography

The Green River Basin is located in West-Central Kentucky and in Northern Tennessee. It comprises a total drainage area of 9,229 sq. mi., with 8,821 in Kentucky and 408 in Tennessee. The Green River Basin encompasses all or portions of 31 counties in Kentucky and 3 in Tennessee. (The Kentucky County Areas are listed in Table F-1 of the Appendix). The Green River is a tributary of the Ohio River, the confluence of the Green River with the Ohio River is 197 miles above the mouth of the Ohio River. The main tributaries of the Green River are the Barren, Nolin, Pond and Rough Rivers. These and other sub-basins with drainage basin areas over 200 sq. mi. are listed in Table F-2 in the Appendix.

#### B. Topography

The primary interest is in the character and slopes of the land and the streams within the basin as they affect water quality. The slope of the land is one of the variables which contributes to water quality. The character indicates the type of land over which the runoff travels before entering the stream. The largest portion of the Green River Basin is in the physiographic region known as the Mississippian Plateau which can be characterized as gently rolling fields, rocky hillsides, and Karst topography. Karst topography has

many sinkholes, underground solution channels and caves. Some wastewater treatment plants and storm water runoff are discharged in the underground formations since the region is without surface streams. The second largest physiographic region is the Western Kentucky Coal Fields with somewhat higher elevations and generally more rugged than the Mississippian Plateau Region. The Mississippian Plateau Region has a lower quantity of runoff and higher runoff quality than the Western Kentucky Coal Field Region.

The quality of the water in a stream can be influenced by the slope of the stream. This effect is demonstrated in the direct relationship between the slope and the capacity of the stream to assimilate waste loads through reaeration. A stream slope of 2 ft./mi. or less produces a low rate of reaeration. A stream slope between 2 and 6 ft./mi. produces a moderate rate of reaeration. Slopes between 6 and 10 ft./mi. produces a high rate of reaeration. The main stem of the Green River flows into the Ohio River at elevation 338 feet above mean sea level (m.s.l.) and is controlled by a series of six locks and dams for navigational purposes. These structures with mile points and pool lengths are listed in Table F-3. Past these structures the river then rises at a gradual slope of 1.6 ft./mi. to the Green River Reservoir at elevation 600 feet above m.s.l. The tributary slopes range from 0.8 ft./mi. to 3 ft./mi. in the lower reaches and 4.7 ft./mi. to 7.7 ft./mi. in the upper regions and the highest elevation is 1,040 feet above m.s.l. A complete list of slopes is included in Table F-2 of the Appendix.

### C. Geology

Surface water quality in the Green River Basin is affected by the parent bedrock, mineral resources and groundwater. The base parent material for most of the Green River Basin is limestone bedrock which produces a bicarbonate type hardness in the water. The Pond River and Rough River sub-basins have sandstone and shale rock layers which produce a sulfate type hardness in the water.

The major mineral resources of the Green River Basin are coal, oil and gas with coal being the largest resource. Generally, coal production in this basin increases acidity and mineralization in the stream. Approximately 40 million tons of coal was produced in the basin in 1972, 94% of which was mined in 3 counties, Muhlenberg (65%), Ohio (16%) and Hopkins (13%). These and other county coal productions are listed in Table F-4 of the Appendix. Approximately 75% of the basin's production in 1972 was done by strip mining on 12.5 sq./mi. A "Soil Conservation Service" basin study indicates about 264 sq./mi. of strip mineable coal still exists. The Green River Basin contributed one-third of the total coal production in 1972, and it has been estimated that coal production in Kentucky by 1985 will reach 400 million tons per year, 3 1/3 times the 1972 figure. A copy of the Commonwealth of Kentucky strip mining slope regulations is included in Table F-5 of the Appendix.

Other mineral resources in the Green River Basin are oil and gas. Oil wells in Kentucky can produce a brine as a waste product. Disposal of brine water other than by reinjection could degrade water quality. In the Green River Basin oil and gas production are not expected to increase in the future.

An important groundwater effect on water quality is the increase in assimilative capacity of the stream due to the substantial amounts contributed to the base flow by springs in the Mississippian Plateau during period of low flow.

Groundwater yields in the Green River Basin range from 50 gallons per minute (g.p.m.) or less in 75 percent of the basin, 50-500 g.p.m. in approximately 24 percent of the basin and 500 to 1,000 g.p.m. in approximately 1 percent of the basin. A map of these regions is included in the Appendix.

## D. Hydrology

The stream flow of the Green River Basin was obtained at six stations: (1) Nolin River at Kyrock, (2) Barren River at Bowling Green, (3) Rough River at the Falls of the Rough River and on the main stem of the (4) Green River at Munfordsville, (5) Lock Number 4 and (6) Lock Number 2. The low flows at all of these stations were augmented by Corps of Engineer Reservoirs. The low flow period for once in 10 years for 7-days is adjusted to include flow augmentation provided by the impoundments. The yields without augmentation are low and a large drainage basin area is needed before a flow occurs. In the Barren River Basin 100 sq. mi. of drainage area will be needed for 2 cubic feet per second/square mile (c.f.s./sq.mi.) of low flow. Because of this flow condition water quality becomes increasingly difficult to maintain during periods of low flow.

GREEN RIVER BASIN FLOW DATA

Station	Period of Record	Drainage Area	Average Flow	Maximum Flow	Minimum Flow	7 Day 10 yr. Low Flow
Nolin River at Kyrock, Kentucky	25 yr.	707 sq. mi.	860 cfs <u>1.22 cfs</u> sq. mi.	22,700 cfs <u>32.11 cfs</u> sq. mi.	0 cfs <u>0 cfs</u> sq. mi.	50.0 cfs <u>0.07 cfs</u> sq. mi.
Barren River at Bowling Green, Kentucky	35 yr.	1,848 sq. mi.	2,442 cfs <u>1.32 cfs</u> sq. mi.	85,000 cfs <u>46.00 cfs</u> sq. mi.	44 cfs <u>.02 cfs</u> sq. mi.	116.0 cfs <u>0.06 cfs</u> sq. mi.
Rough River at Falls of Rough, Kentucky	25 yr.	504 sq. mi.	726 cfs <u>1.44 cfs</u> sq. mi.	12,400 cfs <u>24.60 cfs</u> sq. mi.	6 cfs <u>.01 cfs</u> sq. mi.	50.0 cfs <u>0.10 cfs</u> sq. mi.
Green River at Munford- ville, Kentucky	47 yr.	1,673 sq. mi.	2,598 cfs <u>1.55 cfs</u> sq. mi.	76,800 cfs <u>45.91 cfs</u> sq. mi.	39 cfs <u>.02 cfs</u> sq. mi.	152.4 cfs <u>0.90 cfs</u> sq. mi.
Lock No. 4	36 yr.	5,403 sq. mi.	7,842 cfs <u>1.45 cfs</u> sq. mi.	205,000 cfs <u>37.94 cfs</u> sq. mi.	200 cfs <u>.04 cfs</u> sq. mi.	319.9 cfs <u>0.06 cfs</u> sq. mi.
Lock No. 2	43 yr.	7,564 sq. mi.	10,730 cfs <u>1.42 cfs</u> sq. mi.	208,000 cfs <u>27.50 cfs</u> sq. mi.	280 cfs <u>.04 cfs</u> sq. mi.	319.9 cfs <u>0.04 cfs</u> sq. mi.

NOTE: Data is taken from "Surface Water Records in Kentucky" by the United States Geological Survey. The 7 day 10 year low flow was taken from the waste load allocation produced as a component of the 303e River Basin Continuing Planning Process.

The Karst topography (see Topography) has an influence on the hydrology of the Green River Basin. The sinkholes and underground solution channels store the runoff water during periods of high flows and discharge, through the springs mentioned in the Geology section, the stored volume, after the peak flow in the stream has passed.

In addition to the streams mentioned there are 13 major lakes located within the basin, (Table F-7 of the Appendix). Nine of these are multiple purpose structures, two slurry dams for Peabody Coal Company, one flood retard-ent structure and one for recreation purposes. There are 4 Corps of Engineers Reservoirs with a total area of 29,090 acres at seasonal pool with a total volume of 532,000 acre feet. They are the Nolin River, Green River, Barren River, and Rough River reservoirs. They are all designed and operated for flood control, recreation, low flow augmentation and fish and wildlife purposes, and in addition the Green, Barren and Rough River Reservoirs have volume allocated for water supply. Lakes by the U.S.D.A. Soil Conservation Service and others have 32,200 acre feet of volume. These lakes have no volume allocated or discharge structure needed for low flow augmentation.

#### E. Population

The total population in the basin is 426,000 which is distributed uniformly except for major population centers located in Warren (Bowling Green; 36,400), Hardin (Elizabethtown; 11,700), Barren (Glasgow; 11,300), Hopkins (Madisonville; 15,300), and Muhlenberg (Greenville-Central City; 9,330) counties. Of these major cities Madisonville, Elizabethtown and Glasgow discharge to zero flow streams and have a measurable impact on water quality. Populations of the other basin counties are listed in Table F-8 of the Appendix with the municipalities listed in Table F-9 of the Appendix. The basin population is 35 percent urban and 65 percent rural.

## II. Basin Water Quality

### A. Description of Sampling Stations

The recorded water quality of the basin is presented along with some of the major causes and effects. Also presented are the major uses of surface water in the basin description of the water sampling stations.

There were four stations used in this report to describe the typical water quality within the basin. The first station is on the main stem of the Green River at Munfordville covering 1,673 square miles (sq. mi.) or 18% of the Green River Basin. The second station is located at Bowling Green covering 1,848 sq. mi. or 82% of the Barren River Sub-basin. The third station is on the Green River approximately mid-river at Central City with 6,300 sq. mi. or 68% of the basin area above the station. The fourth station is on the main stem of the Green River near its mouth at Lock No. 1 covering 9,181 sq. mi. or 99% of the basin.

The Pond River near Sacramento was chosen to describe the effect of coal production, on water quality in the Green River Basin. This station is located in the heart of the coal production of Western Kentucky, also some oil production occurs. The drainage area at the station is 523 sq. mi. or 65% of the Pond River Sub-basin. The following discussion of parameters is based upon the data included in Table F-10 of the Appendix.

### B. General Chemical Water Quality

The chemical composition of water is best defined by grouping dissolved elements which compose the total dissolved solids. By examining the relationships of groups of chemicals, the type of water whether hard or soft, salty, acid or high in sulfates reflects the mix of surface and groundwater. The chemical characteristics of a stream when viewed over a long period of time

is primarily from surface water. The type of rock formation and soils which the surface water contacts causes this predominate chemical characteristic. The contribution of groundwater, which is generally higher in dissolved solids than surface water, can be shown by selecting the low flow period for data analyses. The general character of waters in Kentucky is one of moderate hardness caused by calcium and magnesium salts. The influence of mining activities are clearly indicated when the sulfate content increases to a higher level than the bicarbonate content, and the pH is on the acid side, below 5.5.

Oil field operations, when brine is encountered, are reflected by changes in sodium and chloride contents of the water. For Kentucky water, the influence is pronounced when either chloride or sodium exceeds 20 - 25 parts per million as an average value.

The four reporting stations for general water quality reflect different situations on the river.

The Munfordville Station is near the headwaters but below the Green River Reservoir with 18% of the drainage area of the basin. This station has wide fluctuations between average and maximum value (Figure F-1). This station shows water quality in excess of those for Kentucky water particularly the high levels of sodium-(potassium) and chlorides. This can be attributed to an oil boom in Green and Taylor Counties which produced 10 million barrels in 1959. However, the graph for last year's data (Figure F-2) indicates these levels have decreased to pre-oil field conditions due to the decrease in oil production and an increase in control measures.

The station on the Barren River at Bowling Green has approximately the same size drainage basin area as the station at Munfordville but the station at Bowling Green shows a stable water quality which is attributed to the Barren

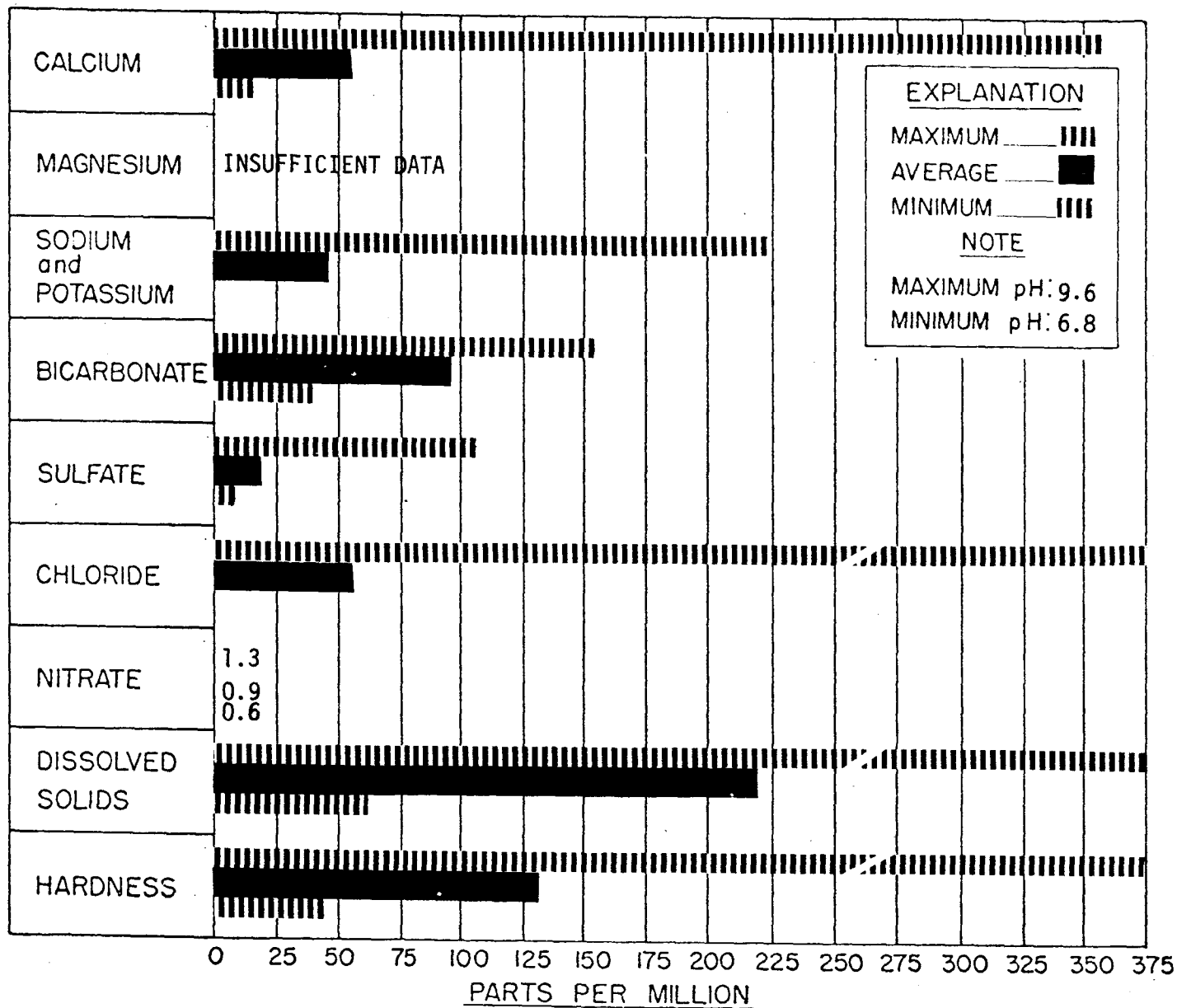
River Reservoir. The graph (Figure F-3) indicates that the natural water quality of the Barren River Basin is a bicarbonate type water with most mineralization (dissolved solids) in the form of calcium bicarbonate.

The Pond River at Sacramento was chosen to depict the influence of coal product on a small drainage basin. Every parameter (Figure F-4) has a higher level in the Pond River except the bicarbonate, which is a measure of the stream's capacity to neutralize acids which demonstrates the effect of acid mine drainage on water quality depleted by acid mine drainage. The bicarbonates have been depleted by acid mine drainage and the effect is also shown by an average pH value of 4.9 with a minimum value of 2.8. To meet the energy crisis coal production is expected to increase over three times the present rate in Kentucky. The effects of coal mining on the Pond River water quality emphasized the influence that a marked increase in coal mining in the Green River Basin can produce on the basin water quality.

The effect of energy related resource development is indicated by comparison (Figure F-5) of the Green River Station at Lock No. 1 (covering 99% of the basin) with the Barren River Station (Figure F-3). The decrease in dominance of the bicarbonate hardness over the sulfate hardness clearly illustrates the increasing influence of coal production on the Green River Basin. The relatively high levels of sodium-(potassium) and chlorides reflect the past influence of the oil production throughout the basin.

At this time, the chemical water quality in the Green River Basin is good, but the demand for coal could have disastrous and long lasting effects on the water quality in the portions of the Green River Basin downstream from these developments. The influence of coal production is long lasting because there is no effective means, known at this time, of treating or eliminating acid mine drainage on a large scale.

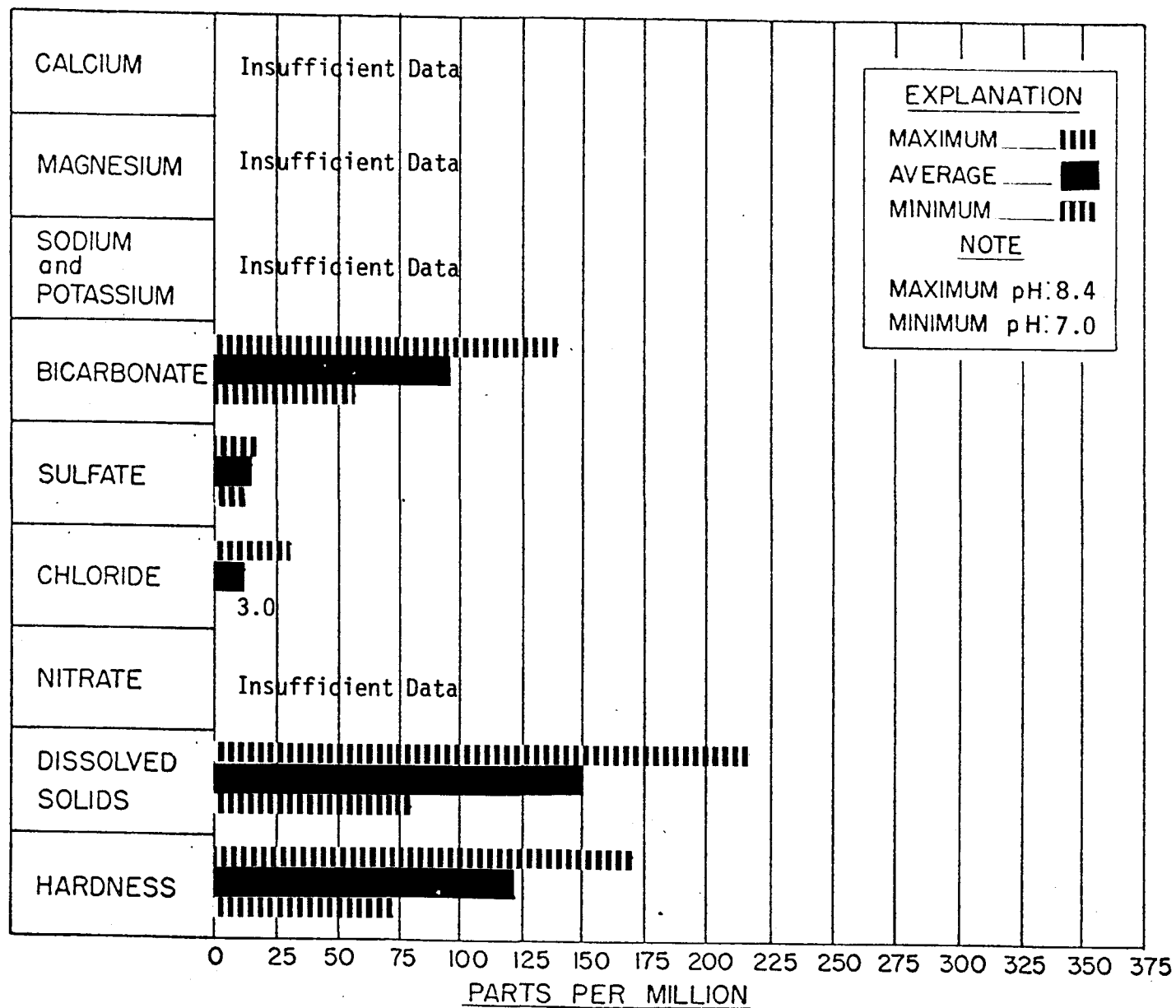




MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,  
 Green River at Munfordville

Period of Record: 1-61 to 9-73

FIGURE F-1



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

Green River at Munfordville

Period of Record: 1-73 to 9-73

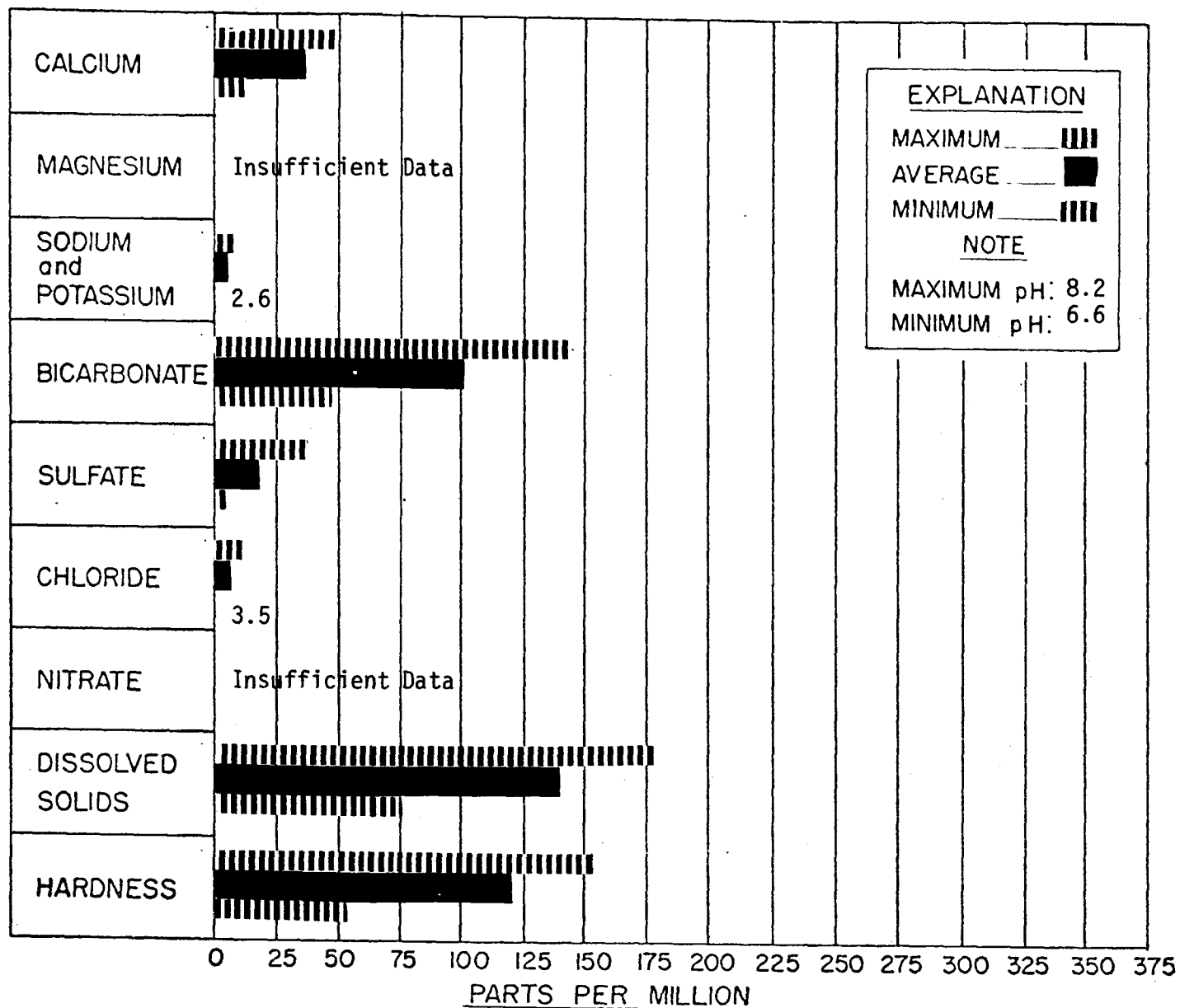
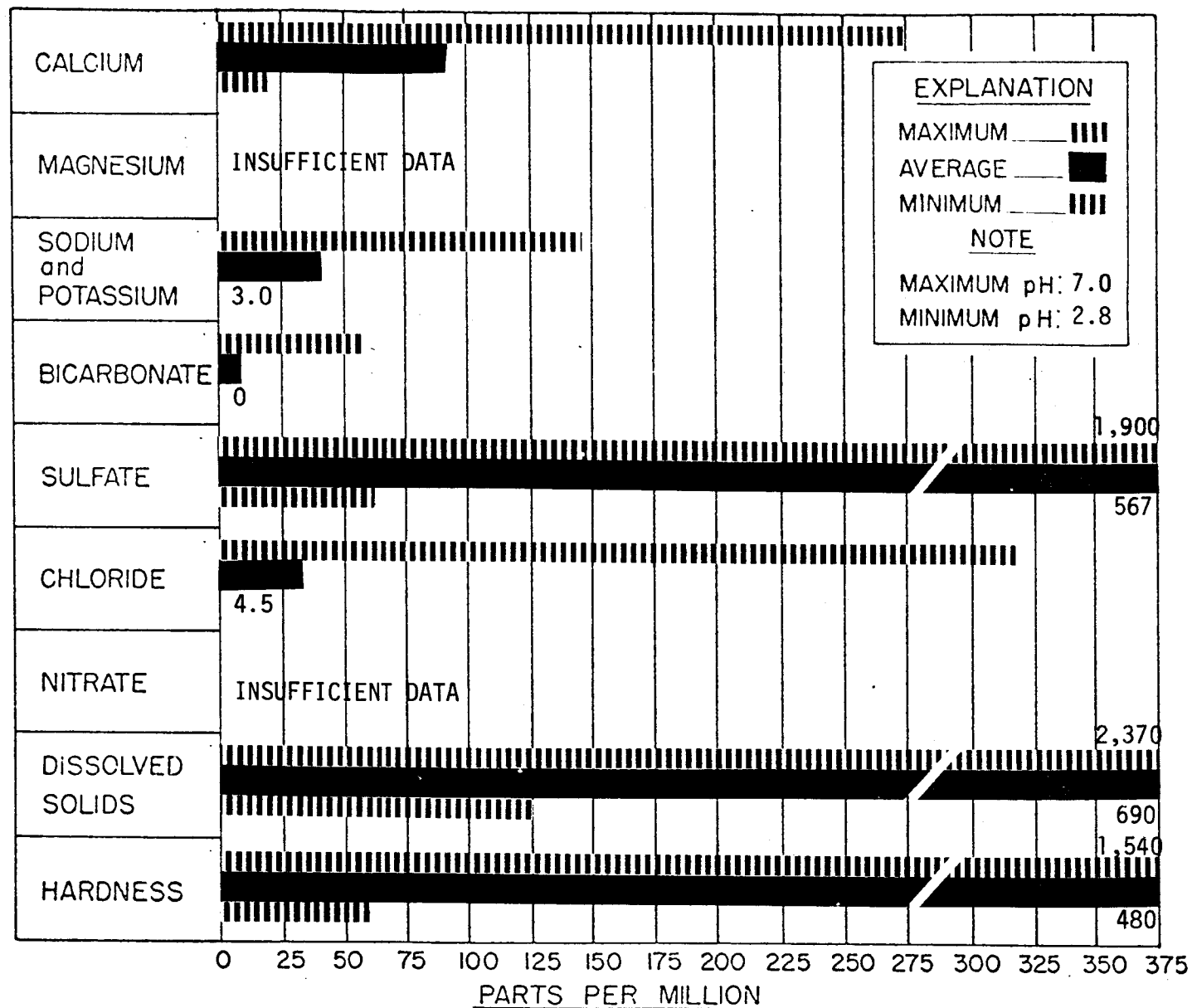


Figure F-3

MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

Barren River at Bowling Green -

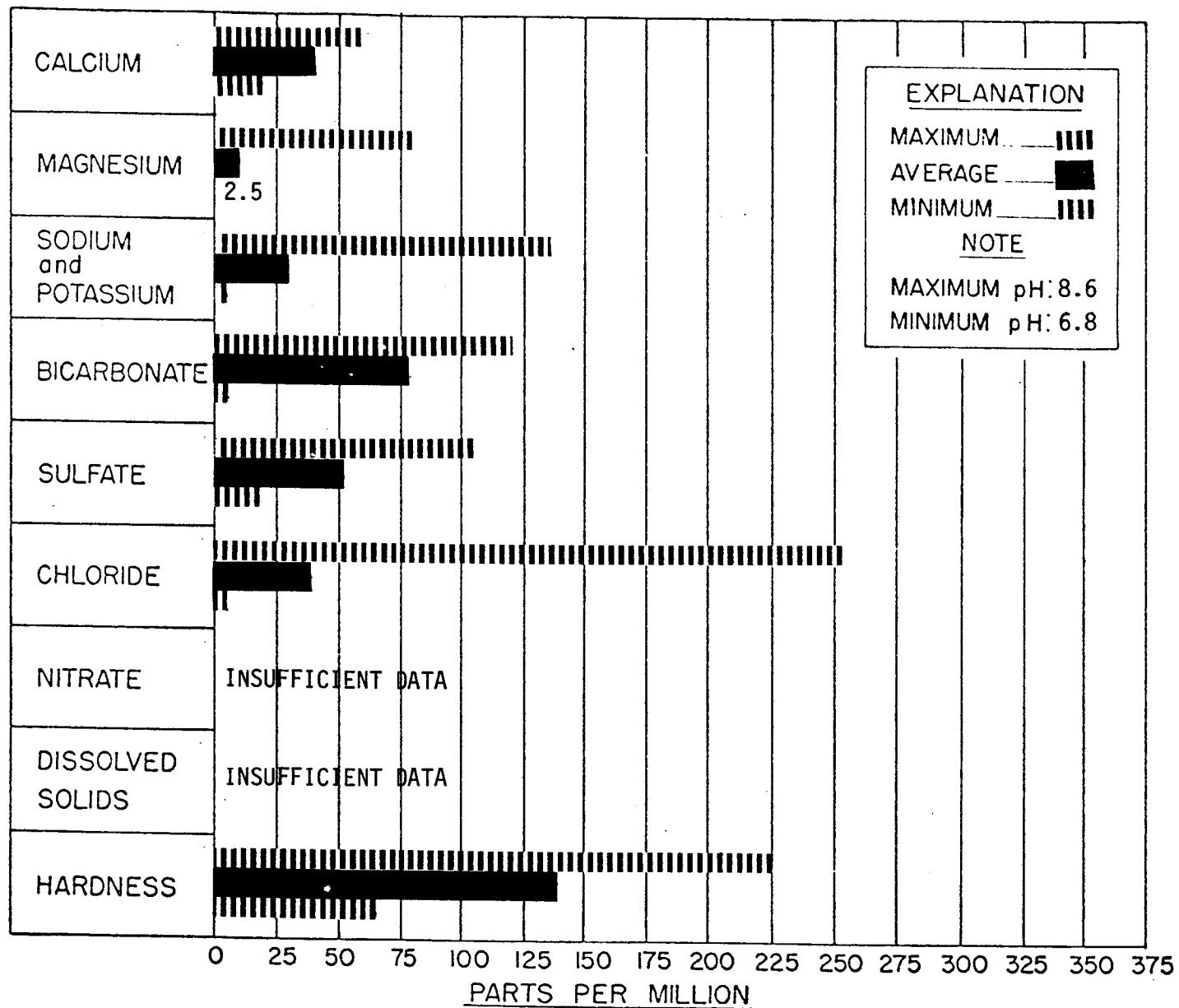
Period of Record: 10-59 to 4-74



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,  
 Pond River, Sacramento

Period of Record: 10-59 to 6-73

FIGURE F-4



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,  
 Green River at Lock 1

Period of Record: 10-59 to 8-72

FIGURE F-5

### C. Trace Chemical Water Quality

Trace elements under 5.0 mg/l are separated from the general chemical background of this report because of their influence on human health. Generally, these materials are "heavy" metals, which in sufficient concentrations have a toxic or otherwise adverse effect on human and animal or plant life. Levels for many of these elements have been established for years in the Drinking Water Standards and more recently through the State-Federal Water Quality Standards.

As a part of the monitoring strategy for Kentucky "Special Surveys" will be undertaken to determine the causes of these levels.

### D. Waste Load Affect on Water Quality

Biochemical degradable waste impose a load on the dissolved oxygen recourses of a stream. Such waste loads are considered to have an adverse effect on water quality when they cause the dissolved oxygen (D.O.) concentration of the water to drop below the Kentucky Water Quality Standard of 5.0 mg/l. Approximately 1,670 miles of stream length were studied using a model to determine waste load allocation. The model was developed for the Kentucky Continuing Planning Process for River Basin Management Planning. Using this model it was determined that approximately 214 miles (12.8 percent) of that length would have a D.O. concentration of less than 5.0 mg/l when the flow is equal or less than the ten year seven day low flow for this period is zero in many of the tributaries and zero flow is expected to occur in small tributaries during most years.

There were 214 miles of stream length affected, of which 172 miles (10.3 percent) will be affected by municipal discharges, 7 miles (0.4 percent) are affected by industrial discharges and 34 miles (2.1 percent) are affected

by other discharges such as schools, trailer parks, subdivision, etc. These results are listed in Table F-11 in the Appendix.

#### E. Non-Point Source Effects

The major non-point sources in the Green River Basin are acid mine drainage, siltation, agricultural runoff, and storm drainage from large cities located near low flow streams. The acid mine drainage and much of the siltation is caused by the coal production which is located primarily in Muhlenberg, Hopkins and Ohio Counties. Small receiving streams affected by acid mine drainage cannot support permanent fish life, and water quality is deteriorated by major increases in hardness (calcium sulfate). A map showing the streams constantly affected by mining is included in the Appendix. Oil production (ten million barrels per year) in Kentucky results in some brine waste, the influence on water quality in the Green River Basin is revealed from the Water Quality graphs.

A Soil Conservation Service report indicates 18 million tons of sediment from erosion is entering the Green River stream system annually.

1. 53 percent of the sediment is produced by erosion from the basin's cropland.
2. 25 percent of the sediment is produced by gully erosion.
3. 12 percent of the sediment is produced by erosion from disturbed forest lands.
4. 10 percent of the sediment is produced from erosion on previously surface mined lands, newly disturbed surface mined lands, 1,600 miles of roadbank erosion and 600 miles of streambank erosion.

siltation impact has been reduced by silt retaining structures, diversion ditches and terraces, but this phenomena will represent a significant problem until quick vegetative cover and good soil conservation practices are universally applied.

Storm water runoff from large cities could represent a significant non-point source where this runoff enters a stream with a small dilution ratio. The cities in the basin in this category are Glasgow, Elizabethtown and Madisonville.

#### F. Water Uses in the Basin

Water uses in the basin are public, industrial, recreational, and fish and wildlife and agricultural.

Public water use consists of 18.6 millions gallons per day, 14.7 million gallons per day of which is from surface water sources and 3.7 million gallons per day is from groundwater sources.

Industrial water usage consists of 10.5 million gallons per day, 9.8 million gallons per day of which is from surface sources and 776,000 gallons per day is from groundwater sources. A complete table for public and industrial water usage (Table F-12) is included in the Appendix.

Approximately 96,000 acres of land and 35,000 acres of water are used for recreational purposes in the area. Four Corps of Engineers' developments account for 29,000 acres of water and 34,000 acres of adjacent land. In 1969, the attendance at the four reservoir areas was nearly 2.9 million visitor days, the Rough River had 1,162,500 visitor days, the Nolin River had 345,500, the Barren River had 875,200, and the Green River had 509,400 visitor days.

Other recreational opportunities exist on 2,600 acres of water in completed PL 566 United States Department of Agriculture, Soil Conservation Service watershed developments and about 3,400 acres of water in State, County, City and privately owned developments.



Habitat for aquatic wildlife and fishes in the basin is provided by 87 principal streams with a total length of 1,600 miles: four large Corps of Engineers' water impoundments; seven other lakes over 100 acres; and numerous smaller lakes and farm ponds. There are 190 species of fishes found in Kentucky and probably 75 percent of these can be found in the Green River Basin.

Generally, water in the basin is widely used in the agricultural industry, primarily for livestock watering with a small amount used for irrigation. In the Pond River sub-basin, water quality is sufficiently degraded that it is not accepted for agricultural usage.

### III. Summary

Water Quality in the Green River Basin is generally good. The water is slightly basic, hard, slightly salty and low in sulfates. Attention is needed, however, in the streams where coal is being produced. Since coal is expected to increase dramatically, the influence on the rest of the basin is likely to become pronounced. Also, 21 municipal discharges need to be upgraded to meet a dissolved oxygen (D.O.) concentration of 5.0 mg/l during periods of low flow. The trace chemical water quality in the Green River Basin is good with the exception of the periodic high lead levels in the Green River at Munfordville and the high fluoride levels in the Pond River at Sacramento. The exact causes of these phenomena are not known at this time and further study is needed. Further study is also needed for the quality of storm water runoff leaving large cities and developed areas and entering small streams.

TABLE F-1

## Drainage Areas in the Green River Basin

	COUNTY AREA (SQ.MI.)	PORTION OF COUNTY (SQ.MI.)	% OF COUNTY IN BASIN
Adair	393	353	90
Allen	364	364	100
Barren	486	486	100
Breckinridge	564	243	43
Butler	443	443	100
Casey	435	341	79
Christian	726	161	22
Daviess	462	378	82
Edmonson	304	304	100
Grayson	512	512	100
Green	282	282	100
Hancock	187	29	16
Hardin	616	400	65
Hart	425	425	100
Henderson	433	121	28
Hopkins	553	278	50
Larue	260	171	65
Lincoln	340	60	17
Logan	563	329	58
McLean	257	257	100
Metcalfe	296	258	87
Monroe	334	225	68
Muhlenberg	481	481	100
Ohio	596	596	100
Pulaski	654	0.1	0.1
Russell	238	67	28
Simpson	239	143	60
Taylor	284	284	100
Todd	376	137	37
Warren	546	546	100
Webster	339	141	42
Sub total	12,988.00	8,821	68
Tennessee Area		408	
Total Drainage Basin		9,229	

Source: Soil Conservation Service Type IV Draft river basin report for the Green River, 1975

Table F-2

## Slopes of Streams in the Green River Basin

<u>Sub-basin</u>	<u>Average Slope (feet/mile)</u>	<u>Drainage Area (mi<sup>2</sup>)</u>
Russell Creek	5.4	289
Little Barren River	7.7	282
Nolin River - Upper Reaches	4.7	727
Lower Reaches	2.5	
Barren River - Upper Reaches	7.7	2,262
Lower Reaches	1.0	
Mud River	3.0	375
Rough River	0.8	1,081
Pond River	1.9	799
Panther Creek	1.5	374
Green River - Upper Reaches	6.6	9,229
Lower Reaches	n/a	

NOTE: This information is from the waste load allocation for Kentucky and is an output from the 303e river basin planning effort.

Table F-3

## Locks and Dams in the Green River Basin

Lock and Dam	Mile	Length of Pool	Pool Elevation
1	9	54	349
2	63	45	363
3	108	36	380
4	145	23	396
5	168	14	411
6	182	18	421
Green River Reservoir	306		

Source: Kentucky Department for Natural Resources and Environmental Protection,  
Division of Water Resources

Table F-4

Coal Production by County and Type of Mining  
in the Green River Basin

<u>County</u>	Coal Mining Methods (Tons)			<u>Total</u>
	<u>Strip</u>	<u>Underground</u>	<u>Auger</u>	
Butler	133,100	71,100	--	204,200
Christian	80,500	--	--	80,500
Daviess	1,012,400	--	--	1,012,400
Henderson	--	92,600	--	92,600
Hopkins	2,333,600	2,752,300	76,000	5,162,600
McLean	1,108,700	--	--	1,108,700
Muhlenberg	20,843,600	5,104,200	136,000	26,083,800
Ohio	4,899,500	1,535,800	--	6,435,300
Totals	30,411,400	9,556,000	212,700	40,180,100
Percent of Totals	75	24	1	100

Source - Annual Report of the Department of Mines and Minerals for Kentucky, 1973.

Table F-5

## Allowable Bench Width in Strip Mining

<u>Slope in Degrees</u>	<u>Maximum Bench Width</u>
12° - 14°	220'
15° - 18°	170'
19° - 20°	155'
21°	140'
22°	130'
23°	120'
24°	110'
25°	100'
26°	90'
27°	80'
<u>Auger Only</u>	
28°	60'
29° - 30°	55'
31° - 33°	45'
33° + No Fill Bench	

Source: Kentucky Department for Natural Resources and Environmental  
Protection, Division of Reclamation

Table F-6

## Oil Production by County for Selected Years in the Green River Basin

County	Year			
	1969	1970	1971	1972
	-Barrels-			
Adair	7,545	275,930	330,750	293,334
Allen	61,850	47,398	39,123	36,073
Barren	11,413	10,106	12,343	11,186
Breckinridge	5,248	5,648	7,766	7,666
Butler	62,124	54,290	47,008	59,827
Casey	12,698	11,872	7,325	5,274
Christian	40,223	38,735	38,293	33,737
Daviess	997,693	786,376	720,236	584,490
Edmonson	449	428	510	368
Grayson	---	---	---	---
Green	112,019	71,042	62,950	44,604
Hancock	11,990	11,426	11,341	10,230
Hardin	---	---	---	---
Hart	16,670	15,390	15,455	13,171
Henderson	555,931	477,206	397,706	328,492
Hopkins	427,640	396,358	414,692	354,246
Larue	---	---	---	---
Logan	746	1,496	741	391
McLean	686,140	584,665	551,354	558,665
Metcalfe	81,638	74,030	62,142	486,541
Monroe	15,447	15,006	12,536	10,955
Muhlenberg	405,689	346,307	300,467	253,187
Ohio	467,421	385,412	328,608	276,390
Pulaski	---	---	---	---
Russell	158	45	49	356
Simpson	2,303	6,744	7,074	6,033
Taylor	43	255	78	---
Todd	55	---	389	453
Warren	23,770	22,364	20,380	21,919
Webster	367,382	281,785	270,452	298,728

Source: Soil Conservation Service Type IV Draft River Report for the Green River, 1975



Table F-7

## Lakes in the Green River Basin

<u>Corps of Engineers Impoundments</u>	<u>Seasonal Capacity</u>	<u>Seasonal Area</u>
Barren River Lake	190,280	10,000 AC
Rough River Lake	90,210	5,100 AC
Nolin Lake	170,200	5,790
Green River Lake	<u>81,500</u>	<u>8,200</u>
Total	532,190 AC-Ft.	29,090 AC

<u>Other Impoundments Over 100 Acres</u>	<u>Capacity (AC-Ft.)</u>	<u>Area (AC)</u>
Lake Herndon	2,265	147
Valley Creek MPS#4	1,830	160
Lake Malone	14,250	826
Shanty Hollow Lake	1,607	135
Big Muddy Creek F.R.S.#2	375	105
Mill Creek MPS#4	1,705	109
Mud River MPS#6A	3,218	240
Peabody Coal - New River Queen Slurry Dam	3,907	162
Peabody Coal - Alston Mine-Area VI Dam	<u>1,180</u>	<u>50</u>
Total	30,330 AC-Ft.	1,930 AC

Source: Kentucky Department for Natural Resources and Environmental Protection,  
Division of Water Resources

TABLE F-8

## Population Distribution in the Green River Basin

COUNTY	1970 URBAN POPULATION**	TOTAL RURAL	TOTAL POPULATION* IN BASIN
Adair	3234	9803	12,100
Allen			12,600
Barren			28,700
Breckinridge	4235	10554	4,550
Butler			9,720
Casey	1765	11165	8,760
Christian	22665	33559	7,450
Daviess	51081	28405	24,000
Edmonson			8,750
Grayson			16,500
Green			10,400
Hancock	2857	4223	670
Hardin	26520	51901	45,800
Hart			14,000
Henderson	23856	12175	3,400
Hopkins	23637	14530	27,900
Larue	3114	7558	8,100
Lincoln	3748	12915	2,270
Logan	9240	7607	15,900
McLean			9,060
Metcalfe	958	7219	7,250
Monroe	2766	8876	8,760
Muhlenberg			27,500
Ohio			18,800
Pulaski			0
Russell	2668	7874	2,210
Simpson	6553	6501	10,500
Taylor	7598	6540	17,000
Todd	3308	7515	2,530
Warren			57,400
Webster	7865	5417	3,620
Total	150,000	276,000	426,000

\* Approximate measurement  $\pm$  10 per cent based on U.S. Census Data

\*\* U. S. Census Data

Table F-9

## Municipalities in the Green River Basin

County	City	Population	Project Type	Comments
Adair	Columbia	3,234	I	Pending
Allen	Scottsville	3,584	I	
Barren	Cave City	1,818	None	
	Park City	567		No sewers
	Glasgow	11,301	III	STP only
Breckinridge				
Butler	Morgantown	1,394	I	
Casey	Liberty	1,765	I	Pending
Christian				
Daviess	Whitesville	752	I	No sewers
Edmonson	Brownsville	542	None	
Grayson	Caneyville	530		No sewers
	Clarkson	660		No sewers
	Leitchfield	2,983	I	
Green	Greensburg	1,990	None	
Hancock				
Hardin	Sonora	390		No sewers
	Elizabethtown	11,748	I	
Hart	Munfordsville	1,233	None	
	Horse Cave	2,068	None	
	Bonnieville	328	I	No sewers, pending
Henderson				
Hopkins	Earlington	2,321	I	
	Hanson	378	I	No sewers, pending
	Morton's Gap	1,169		No sewers
	Nortonville	699		No sewers
	White Plains	729		No sewers
	Madisonville	15,332	I	

Source: Kentucky Department for Natural Resources and Environmental Protection  
Division of Water Quality

Table F-9  
Continued

County	City	Population	Project Type	Comments
Larue	Upton	552		No sewers
	Hodgenville	2,562	I	
Lincoln				
Logan	Auburn	1,160	None	
	Lewisburg	651	None	
McLean	Calhoun	901	None	
	Sacramento	437		No sewers
	Island	410	I	No sewers
	Livermore	1,594	I	
	Calhoun	901	III	STP only
Metcalfe	Edmonton	958	None	
Monroe	Gamaliel	431		No sewers
	Tompkinsville	2,207	I	Pending
	Fountain Run	128	I	
Muhlenberg	Powderly	631		No sewers
	Drakesboro	907	I	No sewers
	Greenville - Central City	9,325	I	Pending
Ohio	Beaver Dam	2,622	None	
	Hartford	1,868	None	
	Fordsville	489	I	No sewers
	Centertown	323		No sewers
	McHenry	420		No sewers
	Rockport	377		No sewers
Pulaski				
Russell				
Simpson	Franklin	6,553	I	Pending
Taylor	Campbellsville	7,598	I	
Todd				
Warren	Smiths Grove	756		No sewers
	Woodburn	351		No sewers
	Bowling Green	36,253	I	
	Bowling Green	36,253	III	STP Only

Table F-9  
Continued

County	City	Population	Project Type	Comments
Webster	Sebree Slaughters	1,092 276	None I	Pending

NOTE: Project type is related to the type of grant applied for or received by each city. Type I is for preliminary studies necessary before design of the facility. Type II is the design phase of a facility and Type III is for the construction of a facility for the collection and treatment of domestic sewage.

The comments relate to the status of the grant. Underway indicates the project type is funded. Pending indicates that application for a grant has been made and is pending approval and no sewers means when a grant is requested that it is for a complete and original system.

The source of this information was the 1970 U.S. Census and the FY 75 construction grants list for Kentucky.

Table F-10

## Water Quality Data for Green River Basin

Station	#Obs.	Mean	S	Max.	Min.	Beg. Date	End Date
pH Specific Units Kentucky Standard (Ky. Std.) 6 to 9							
Green River, Munfordville	330	7.7	0.4	9.6	6.8	1-61	9-73
	14	7.9	0.1	8.4	7.0	1-73	9-73
Barren R., Bowling Green	40	7.5	0.2	8.2	6.6	10-59	4-74
Pond River, Sacramento	70	4.9	2.0	7.0	2.8	10-59	6-73
Green R., Lock No. 1	33	7.5	0.1	8.1	6.8	10-59	8-72
Conductivity micro mhos, Ky. Std. 800 micro mhos							
Green R., Munfordville	364	400	240	1,750	47	1-61	9-73
	14	250	70	390	149	1-73	9-73
Barren R., Bowling Green	53	250	40	321	116	10-59	5-74
Pond R., Sacramento	75	1,150	820	3,230	143	10-59	6-73
Green R., Lock No. 1	78	390	180	1,080	154	10-59	8-72
Dissolved Solids mg/l, Ky. Std. 500 micro mhos							
Green R., Munfordville	355	220	130	1,040	61	1-61	9-73
	14	150	40	216	80	1-73	9-73
Barren R., Bowling Green	15	140	30	177	75	10-59	5-74
Pond R., Sacramento	16	690	670	2,370	124	10-59	6-73
Alkalinity mg/l, No Standard							
Green R., Munfordville	210	96	25	153	40	10-59	9-73
	14	96	33	141	57	1-73	9-73
Barren R., Bowling Green	33	101	16	141	46	10-59	5-74
Pond R., Sacramento	47	9	13	57	0	10-59	6-73
Green R., Lock No. 1	37	78	21	119	6	10-59	8-72
Hardness mg/l, 0-60 soft, 61-120 mod. hard, 121-180 hard, over 180 very hard							
Green R., Munfordville	327	130	50	387	45	1-61	9-73
	14	120	30	170	71	1-73	9-73
Barren R., Bowling Green	41	120	20	157	52	10-59	5-74
Pond R., Sacramento	65	480	360	1,540	58	10-59	6-73
Green R., Lock No. 1	70	140	30	225	64	10-59	8-72
Color Platinum - Cobalt Units, Prop. E.P.A. Std. 75 units							
Green R., Munfordville	250	9	9.6	55	0	10-59	10-72
Barren River, Bowling Green	14	7	9.3	38	0	10-59	3-71
Pond River, Sacramento	48	7	11.0	56	0	10-59	6-73
Green River, Lock No. 1	47	8	8.2	40	1	10-59	4-71

Table F-10  
Continued

Station	#Obs.	Mean	S	Max.	Min.	Beg. Date	End Date
Sodium mg/l, No Standard							
Green River, Munfordville	66	43	41	218	3.5	1-61	10-73
Barren River, Bowling Green	17	4	1.0	5.6	2.1	10-59	5-74
Pond River, Sacramento	37	39	32	139	5.4	10-59	6-73
Green River, Lock No. 1	55	28	28	132	4.2	10-59	4-71
Potassium mg/l, No Standard							
Green River, Munfordville	20	2.2	1.0	5.2	0.8	11-59	10-72
Barren River, Bowling Green	17	1.4	0.6	2.6	0.5	10-59	5-74
Pond River, Sacramento	37	3.2	1.7	8.5	0.9	10-59	6-73
Green R., Lock No. 1	53	2.0	0.8	4.1	0.9	10-59	4-71
Chloride mg/l, Prop. E.P.A. Std. 250 mg/l							
Green River, Munfordville	355	54	64	455	3.0	1-61	9-73
	14	12	7.6	30	3.0	1-73	9-73
Barren River, Bowling Green	41	7	1.8	11	3.5	10-59	5-74
Pond River, Sacramento	68	34	45	318	4.5	10-59	6-73
Green River, Lock No. 1	70	40	52	254	5.0	10-59	8-72
Sulfate mg/l, Prop. E.P.A. Std. 250 mg/l							
Green River, Munfordville	328	18	7.0	106	7.4	1-61	9-73
	14	16	2.3	22	13	1-73	9-73
Barren River, Bowling Green	41	18	5.1	36	8	10-59	5-74
Pond River, Sacramento	69	567	488	1,900	62	10-59	6-73
Green River, Lock No. 1	70	51	22	107	17	10-59	8-72
Nitrate - N mg/l, Prop. E.P.A. Std. 10 mg/l							
Green River, Munfordville	35	0.9	0.3	1.6	0.4	3-72	9-73
	14	0.9	0.2	1.3	0.6	1-73	9-73
Fluoride mg/l, Ky. Std. 1.0 mg/l							
Green River, Munfordville	49	0.4	0.3	0.9	0.07	1-70	11-74
	21	0.5	0.3	0.9	0.10	1-73	11-74
Barren River, Bowling Green	51	0.3	0.3	0.9	0.0	5-69	10-74
	19	0.4	0.3	0.9	0.1	1-73	10-74
Green River, Central City	47	0.4	0.3	0.9	0.0	2-70	10-74
	15	0.5	0.3	0.9	0.1	1-73	10-74
Pond River, Sacramento	43	1.0	0.9	3.2	0.0	10-59	6-73
Green River, Lock No. 1	50	0.2	0.1	0.5	0.0	10-59	8-72
Calcium mg/l, No Standard							
Green River, Munfordville	142	55	40	356	15	10-59	10-72

Table F-10  
Continued

Station	#Obs.	Mean	S	Max.	Min.	Beg. Date	End Date
Barren River, Bowling Green	17	37	7	48	17	10-59	10-72
Pond River, Sacramento	37	92	65	274	18	12-73	10-74
Green River, Lock No. 1	55	40	10	62	20	10-59	4-71

Magnesium mg/l, No Standard

Green River, Munfordville	142	11.7	10	80	2.5	10-59	10-72
Barren R., Bowling Green	17	6.8	2	12	2.3	10-59	5-74
Pond River, Sacramento	37	42.2	38	158	5.8	10-59	6-73
Green River, Lock No. 1	55	9.3	3	18	3.5		

Cadmium micrograms/liter, Ky. Std. 100 ug/l

Green R., Munfordville	52	1.9	7.0	5	0	1-70	11-74
	21	0.9	0.4	2	0	2-73	11-74
Barren R., Bowling Green	48	1.1	0.9	5	0	1-70	10-74
	19	1.0	0.5	2	0	7-73	10-74
Green R., Central City	43	1.0	0.7	3	0	2-70	10-74
	15	0.9	0.5	2	0	1-73	10-74

Manganese micrograms/liter, Prop. Ky. Std. 50 ug/l

Pond River, Sacramento	24	4,930	4,710	17,000	220	10-59	6-73
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Iron micrograms/liter, Prop. E.P.A. Std. 300 ug/l

Green River, Munfordville	14	50	85	330	0	10-65	9-66
Barren River, Bowling Green	14	290	610	2,400	0	10-59	7-72
Pond River, Sacramento	24	1,050	880	3,200	90	10-59	6-73

Chromium micrograms/liter, Ky. Std. 50 ug/l

Green River, Munfordville	50	1.2	1.2	5	0	1-70	11-74
	14	1.4	1.5	5	0	2-73	11-74
Barren River, Bowling Green	51	0.9	0.9	4	0	5-69	10-74
	15	1.1	0.7	3	0	1-73	10-74
Green R., Central City	45	1.5	1.3	5	0	2-70	10-74
	15	2.3	1.5	5	0	1-73	10-74

Lead micrograms/liter, Ky. Std. 50 ug/l

Green River, Munfordville	51	53	122	770	1	1-70	11-74
	21	61	84	203	6	1-73	11-74
Barren River, Bowling Green	48	10	9	53	0.3	5-69	10-74
	19	13	7	35	5	1-73	10-74
Green River, Central City	43	15	17	78	0.1	2-70	10-74
	15	19	18	78	6	1-73	10-74



Table F-10  
Continued

Station	#Obs.	Mean	S	Max.	Min.	Beg. Date	End Date
Silver micrograms/liter, Ky. Std. 50 ug/l							
Green River, Munfordville	51	0.73	0.7	3	0	1-70	11-74
	22	0.86	0.3	1	0	1-73	11-74
Barren River, Bowling Green	51	0.75	0.9	3	0	5-69	10-74
	19	0.68	0.5	1	0	1-73	10-74
Green River, Central City	44	0.61	0.5	2	0	2-70	10-74
	15	1.00	0.0	1	1	1-73	10-74
Arsenic micrograms/liter, Ky. Std. 50 ug/l							
Green River, Munfordville	11	0.45	0.5	1	0	1-71	4-74
Barren River, Bowling Green	14	0.36	0.6	2	0	1-71	4-74
Green River, Central City	14	0.57	0.6	2	0	1-71	4-74
	6	0.33	0.5	1	0	1-73	4-74

#Obs: Total number of observations in period shown

S: Standard Deviation

Table F -11

Organic Loads Affecting Streams in the Green River Basin

Length of streams to which treated organic loads are discharged	1,670
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow with present treatment	214
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow due to with present treatment	
	Municipal Discharges 173
	Industrial Discharges 6.8
	Other Discharges 34.5

NOTE: This information is from the waste load allocation for Kentucky and is an output from the 303e river basin planning effort. The values indicate the stream miles in which the dissolved oxygen is predicted to be less than 5 mg/l when the stream flow is less than the once in ten year seven day (Q 10-7) low flow.

Table F-12

## Water Usage for Industry and the Public in the Green River Basin

County	City	Surface		Ground	
		Public	Industrial	Public	Industrial
Adair	Columbia	267,000	2,700		
Allen	Scottsville			456,000	114,000
Barren	Glasgow Res.	867,000			
	Glasgow Creek	1,300,000	229,000		
	Park City			40,000	
Breckinridge	Kingswood			15,000	
Butler	Morgantown	180,000			
	Rochester	27,700	300		
Casey	Liberty	116,000	38,800		
Christian					
Daviess	Whitesville			40,400	
Edmonson	Bee Spring			1,360	
	Edmonson C.W.D.	265,000			
	Brownsville			60,100	
	Mammoth Cave			73,600	
Grayson	Caneyville	22,300	500		
	Leitchfield			279,000	45,400
Green	Gabe	3,500	172,000		
	Greensburg	172,000	43,000		
	Nally Gibson		24,000		
Hancock					
Hardin	Elizabethtown			1,630,000	16,400
	Upton			45,000	5,000
Hart	Horse Cave			525,000	45,700
	Munfordsville	82,100	11,200		
Henderson	Anaconda Alum.		639,000		

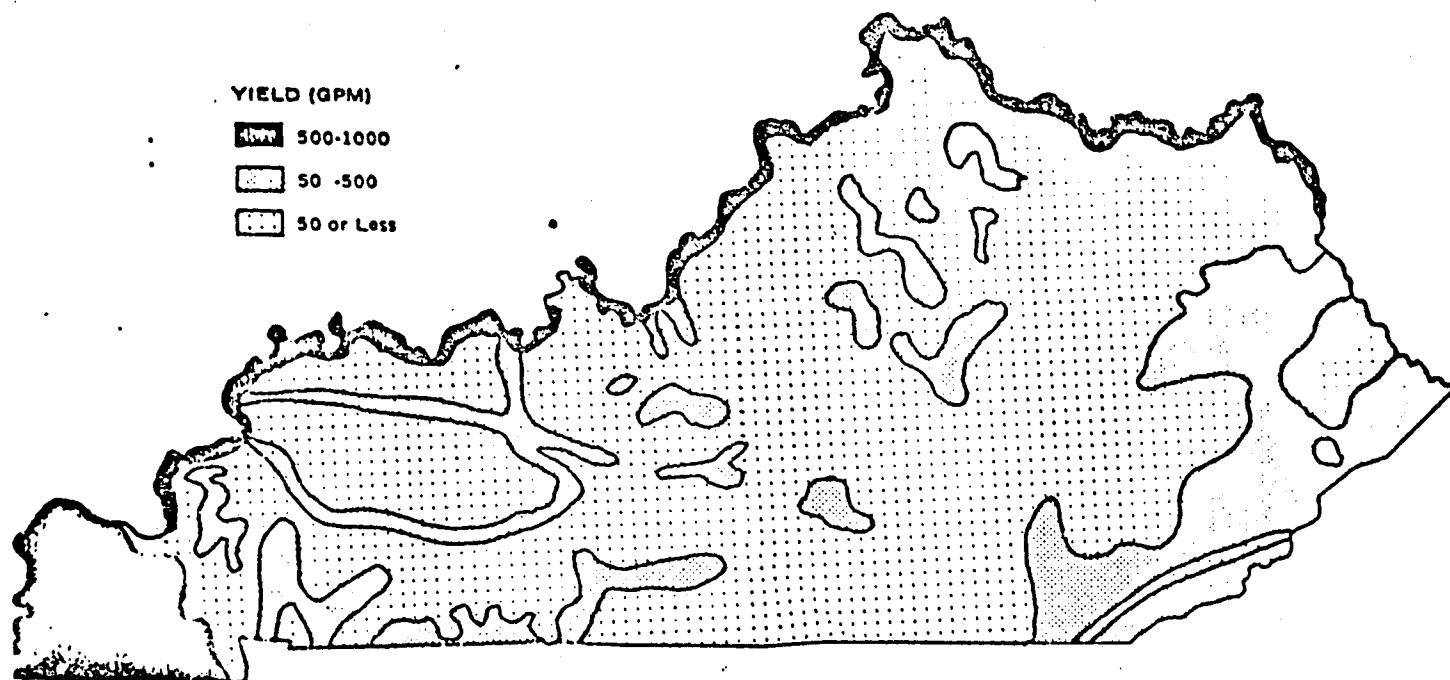
Table F-12  
Continued

County	City	Surface		Ground	
		Public	Industrial	Public	Industrial
Hopkins	Earlington	148,000			
	Madisonville	1,790,000	268,000		
	Nortonville			75,600	3,900
	White Plains			17,100	900
	Cimmarron Coal		288,000		
	Island Creek Coal		39,800		
Larue	Hodgenville	190,000			
	Auburn Dyeing		12,700		
	Auburn			93,200	23,200
	Caldwell Lace		25,700		
	Lewisburg	43,300	4,800		
	Russellville	436,000	387,000	16,900	14,900
McLean	Calhoun	133,000	133,000		
	Livermore	128,000	14,200		
	Sacramento			19,750	
Metcalfe	Edmonton	48,800	5,400		
Monroe	Gamaliel	49,000			
	Res and Creek				
	Tompkinsville	125,000	75,000		
Muhlenberg	Central City	713,000	75,000		
	Gilbrater Coal		1,520,000		
	Pittsburg Midway		164,000		
	Drakesboro			102,000	1,000
	Graham	17,100	175		
	Greenville	323,000	17,000		
	Kirkpatrick Mine		35,000		
	Wright Coal		79,400		
	(Madisonville)				
	Peabody Coal		739,000		
Ohio	(Beaver Dam)				
	Peabody Coal		469,000		
	Fordsville	48,000			
	Hartford	227,000	12,000		
	Ohio C.W.D.	310,000	77,500		
	Rockport	60,400			
	Peabody Coal		288,000		
	(Hartford)				
	Peabody Coal		590,000		
Pulaski					
Russell					

Table F-12  
Continued

County	City	Surface		Ground	
		Public	Industrial	Public	Industrial
Simpson	Franklin	709,000	382,000		
Taylor	Campbellsville	600,000	900,000		
	Res. and Creek Tennessee Gas Piping		183,000	4,000	
Todd					
Warren	Bowling Green	5,230,000	922,000		
	Beech Bend			10,000	
	Warren C.W.D.			131,000	
	Pet Milk Smiths Grove			55,000	460,000 600
Webster	Dixon	65,000			
	Sebree			76,000	1,000
	Texas Gas (Slaughters)				44,500
	Slaughters	44,000			
		14,700,000	9,800,000	3,770,000	777,000

Source: Kentucky Department for Natural Resources and Environmental Protection  
Division of Water Resources



# Streams Affected by Mine Drainage

STREAMS CONTINUOUSLY OR SIGNIFICANTLY AFFECTED

